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A MATHEMATICAL ANALYSIS OF THE CURVE OF DEATHS AT DIFFERENT AGES.

The statistical and mathematical study of variation, as carried out by Galton and Pearson in England, by Davenport in this country, and by many others, has created almost a revolution in biological methods of research, and marks a great step in the transformation of biology from an observational to a logical science. No contribution to this subject has been more significant than some recent work on the curve of mortality at different ages. This branch of research was first suggested by Professor Lexis (*Einleitung in die Theorie der Bevölkerungsstatistik*, 1875, *Zur Theorie der Massenerscheinungen*, 1877, *Sur la durée normale de la vie humaine*, *Compte rendu des seánces de Congrès international de demógraphie*, Paris, 1878), who pointed out that, when a curve is constructed with the number of deaths in a population as ordinates and the ages at death as abscissæ, the old age portion of the curve strikingly resembled a normal curve of frequency. Karl Pearson in 1897 (The Causes of Death) applied the more refined methods of statistical study to this problem with remarkable results. First he found that the statistics of French and English mortality could not be made to coincide with Lexis' scheme, — until for the normal curve of chance distribution he had substituted a skew frequency curve, or one in which the mean and the mode do not coincide. A curve of this character, - such as is commonly found on plotting the variations in the organs of plants and animals was found to correspond with the actually observed curve for English males; the mean was at 67 years, and the mode at 72. When this portion of the mortality had been removed the curve of the next section of mortality was found to coincide with a second chance distribution curve, centering, with only a negligible skewness, about the forty-second year. A third component curve of the same character had its mode at 23, a fourth had a mode at three years and a mean at six; and, finally, the last 246 deaths out of a thousand may be regarded as lying on a curve, including also an ante-natal mortality of 605, with a mode at about the beginning of the last ante-natal month and extending to the limit of gestation, nine months before birth. The statistics for the first three months are unobtainable; those recorded for the last six months of ante-natal life indicate a lower value than that required by Professor Pearson's calculation; but they are, to a great extent, incomplete and unreliable. The standard deviations of these five curves are of special interest; beginning with the old age component they are as follows: 13.4, 12.8, 7.8, 3.5, and .9. The number of deaths per thousand total deaths are 484, 173, 51, 46, and 246 (+ 605 ante-natal deaths).

In the article entitled *La Mortalità nei vari stadi della vita* in the *Bulletin de l'Institut International de Statistique*, xi, 267, Dr. E. Raseri has applied Professor Pearson's method to Italian statistics. He finds himself unable to harmonize still-births and the diseases of infancy with any theory; the diseases of adult life are, however, plotted so as to show the three later components of Professor Pearson's with great clearness. The curve of old age lacks the pronounced skewness shown by the English statistics, indicating a greater stability, and its mode is at 72 years with a standard deviation of 5 years and 9 months; the second curve has a mode at 52 years and a standard deviation of 4 years and 9 months; the third curve culminates at 25 years with a deviation of 7 years, 9 months. The coincidence of the statistical and theoretical curve is even closer than in the English diagrams; the total number of deaths in the component groups during the periods 1890–98 was as follows: —

	Old Age.	Middle Life.	Youth.	Infancy.
Males, . . .	109,229	38,269	48,240	192,282
Females, . . .	111,583	30,757	58,003	174,712

If the analysis of mortality statistics by the application of these four or five curves is found to be applicable to other populations its practical value will be very great. Dr. Raseri appends to his paper a table of deaths from the principal causes, arranged by five-year periods, in which it is clear that bronchitis and diarrhœal diseases contribute mainly to the infantile curve, and typhoid fever and tuberculosis to the twenty-five-year component; while pneumonia attains its maximum in middle life, and apoplexy and diseases of the circulatory system in old age. It is obvious, therefore, that a most significant view of the sanitary condition of a population may be obtained by a comparison of the relative magnitude and position of the component curves. Thus, by comparing Pearson's work with Raseri's, we get the following result: —

COMPONENT CURVES OF MORTALITY.

	Infancy.	Youth.		Middle Life.		Old Age.	
	Magnitude.*	Mode†	Magnitude.	Mode.	Magnitude.	Mode.	Magnitude.
Italy	495	25	124	52	99	72	282
England	292	23	51	42	173	72	484

* Per 1000 total deaths. † Years.

It must, of course, be remembered that this sort of study while profitable is also full of pitfalls for the unwary; and one can draw no conclusions from such figures as have been quoted without a thorough scrutiny of the mathematics and of the logic of the investigator.

C.-E. A. WINSLOW.

MICHIGAN VITAL STATISTICS.

The *Thirty-second Annual Report of the Secretary of State on the Registration of Births, Deaths, and Marriages in Michigan for the year 1898.* Edited by Cressy L. Wilbur, M.D., Chief of Division of Vital Statistics. Lansing, Michigan, 1900.

While this report is the thirty-second in a series, it marks a new departure in the history of registration in Michigan, since all of the previous reports were much less complete in consequence of serious defects in the registration laws of the State. Under the new law of 1897 a certificate of death must be presented to the local registrar in every case of death before burial is permitted. Under the old law the statistics of deaths were collected once a year, at the time of taking the annual assessment, and it was estimated that only 60 per cent of the deaths were thus collected.

According to this report for the year 1898 the returns were as follows: —

Total number of births, 1898,	43,462
Birth rate per 1,000 of the estimated population,	18.2
Total number of marriages, 1898,	20,138
Marriage rate (persons married) per 1,000,	16.9
Total number of deaths, 1898,	29,557
Death rate per 1,000,	12.4